Collaboration in Decisions and Planning: Diagrams, Gesture, and Language

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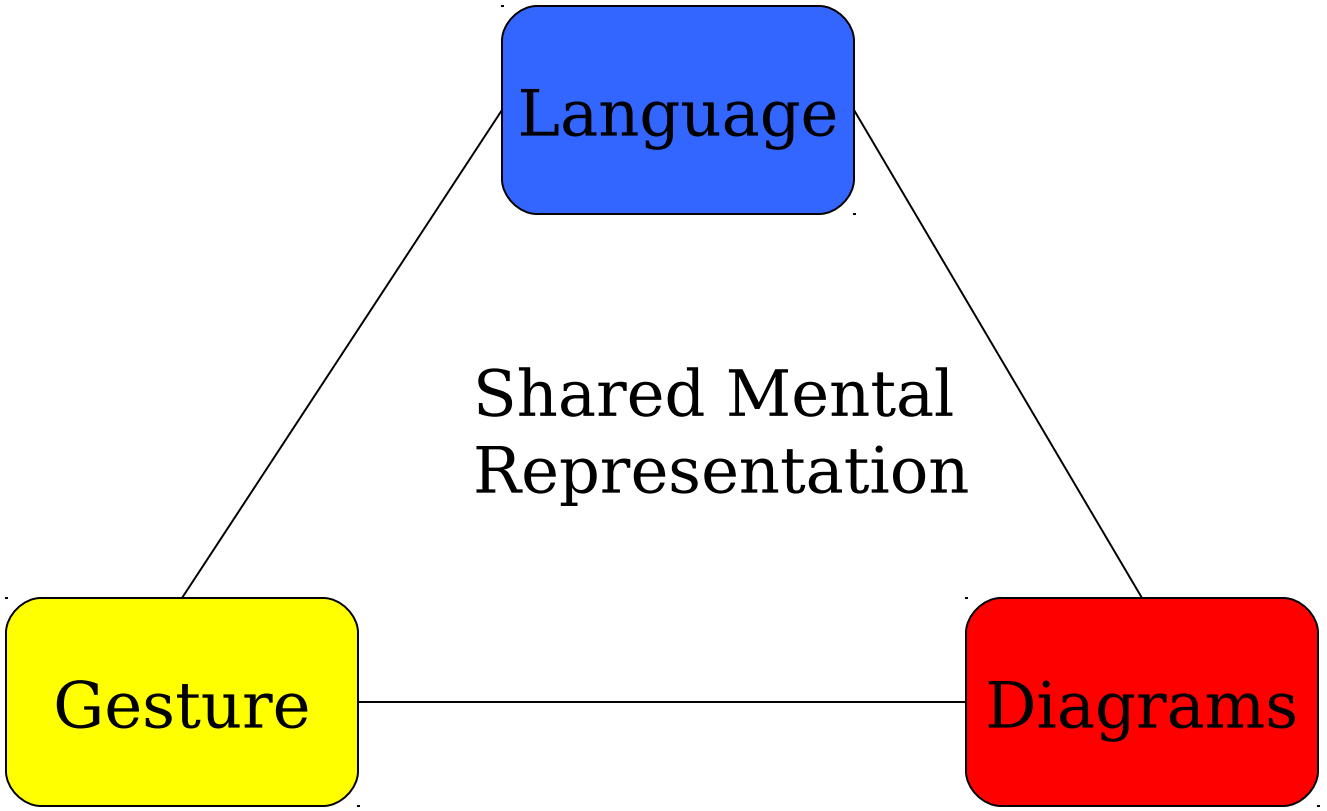
Objectives

- Understand roles of language, gesture and externa representations in collaborative planning and decision-making
- Investigate ways diagrams serve collaborative communication
- Create guidelines for effective collaborative system

Key Terms



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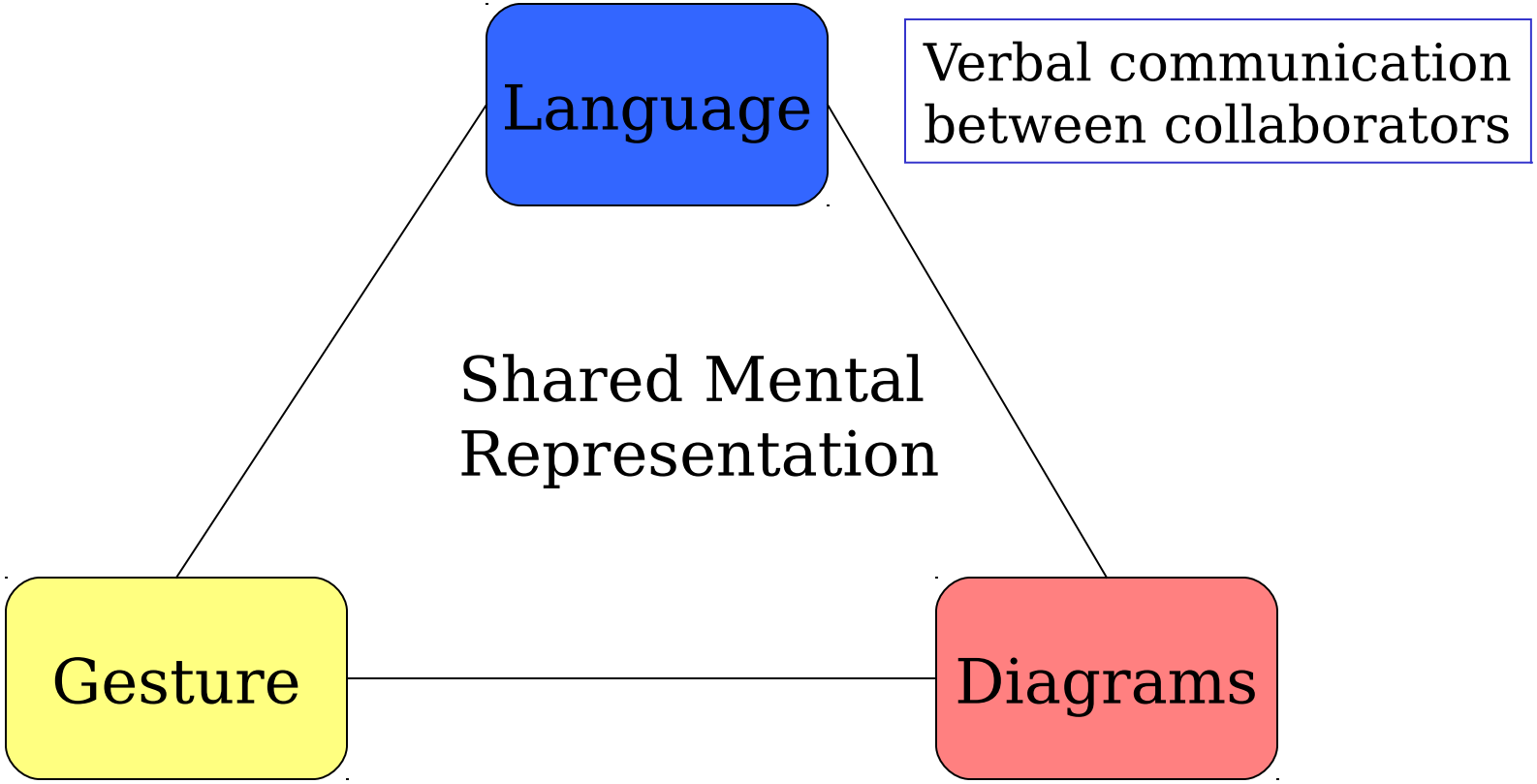
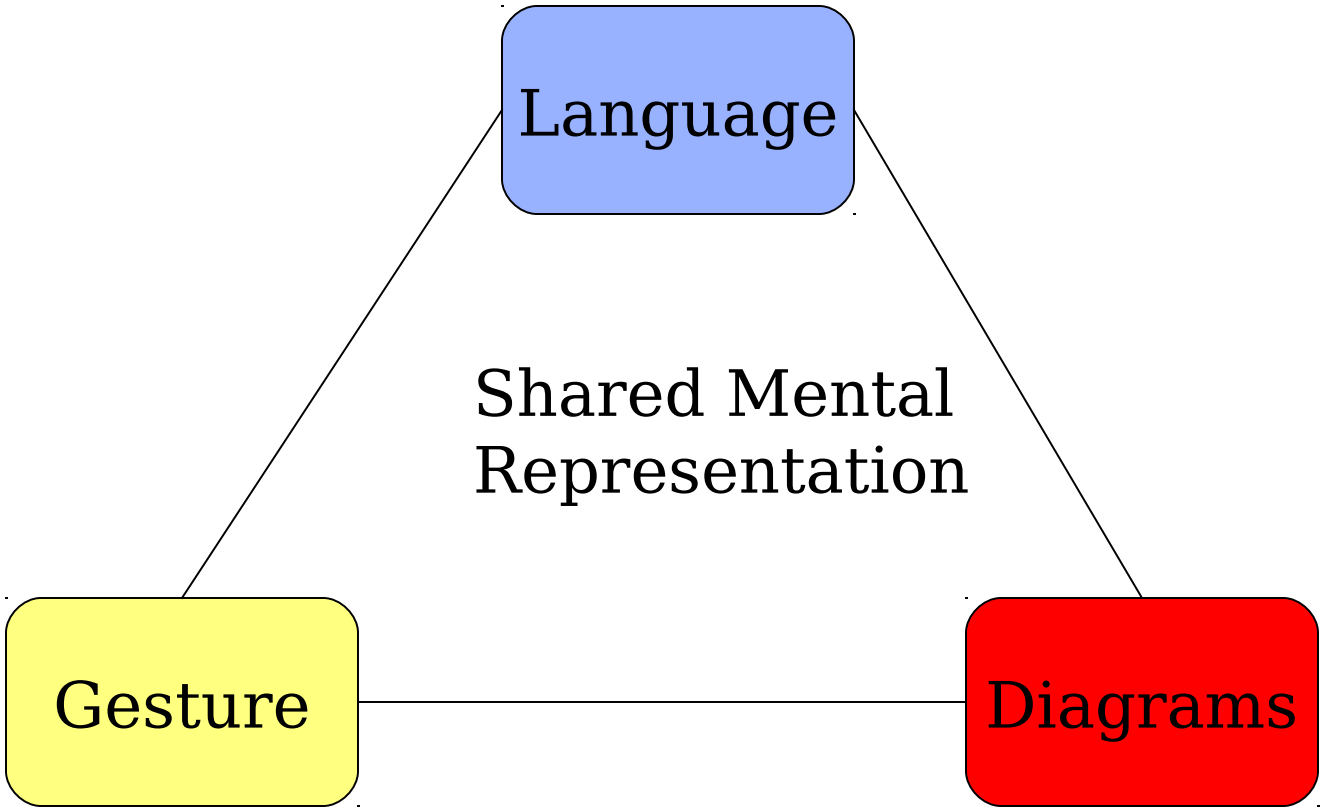
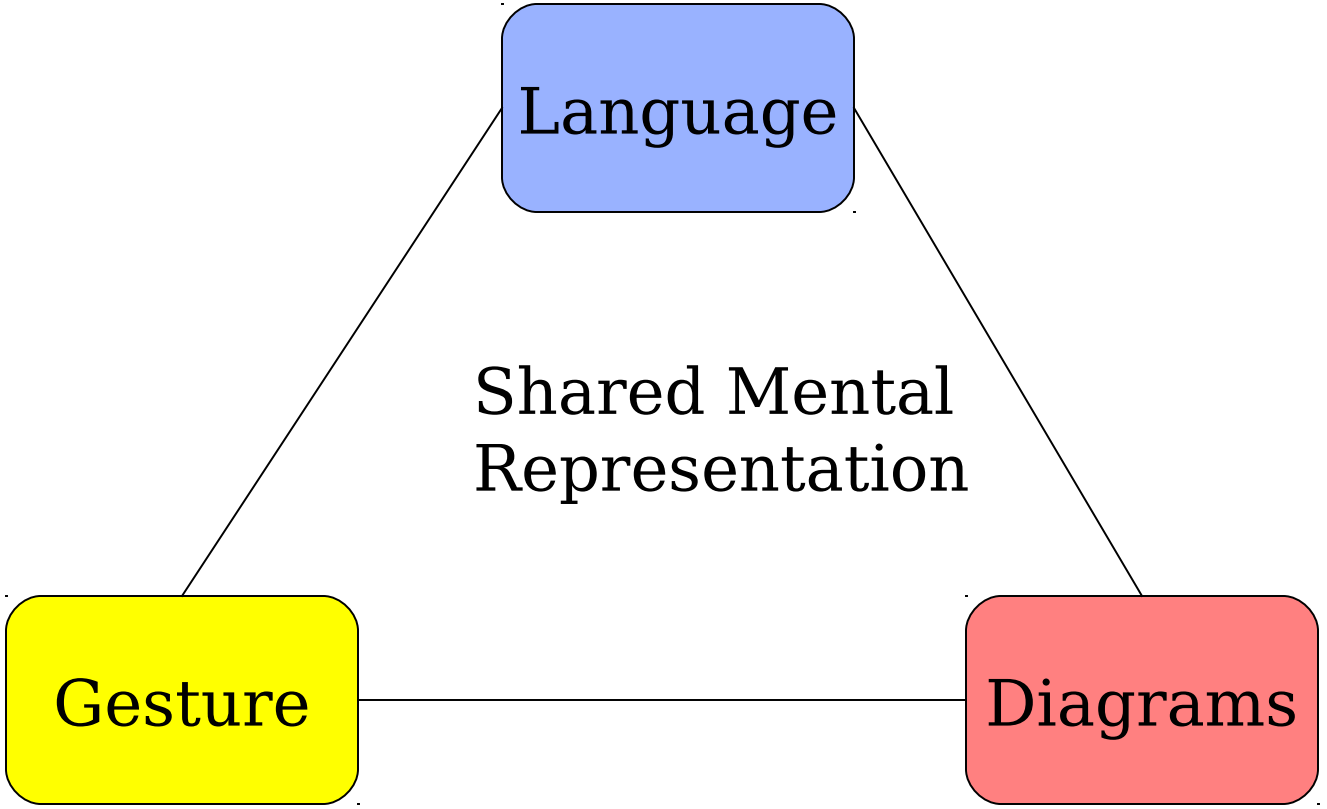

Language
Verbal communication between collaborators
Shared Mental Representation
Gesture
Diagrams

Key Terms



External representation of collaboration topic, e.g. map or diagram

Key Terms



Non-verbal communication between collaborators, i.e. pointing

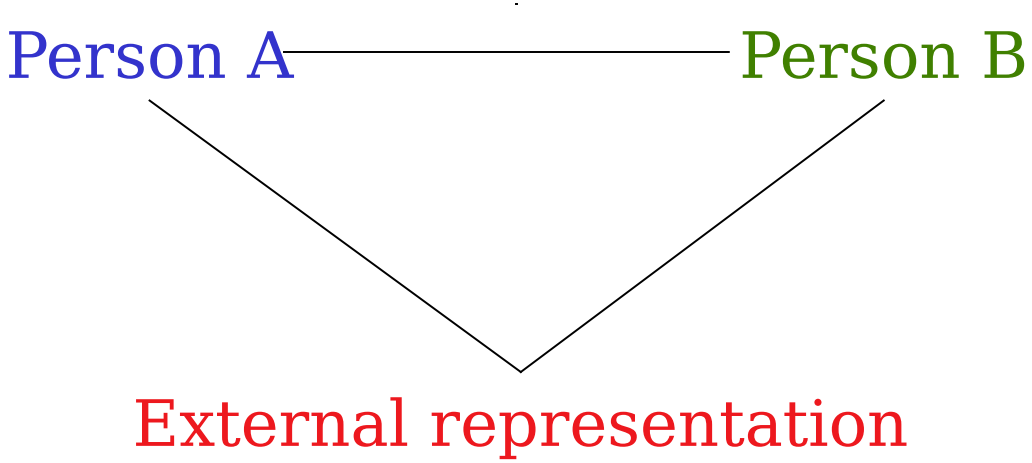
External representations

QuickTime™ and a
H.263 decompressor
are needed to see this picture.

External representations

Model of Collaboration

Individuals in collaboration:



External representation:

- establishes common ground
- serves as external slate for reasoning

Research Questions

- What is the nature of collaboration?
  - How are tasks divided and assigned?
  - What roles do each participant adopt?
  - Similarities/differences between manual and intellectual collaborations

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- What are the roles of diagrams in collaborative planning and decision making?
  - Facilitate joint understanding
  - Facilitate joint reasoning

Research Questions

- What is the nature of collaboration?
    - How are tasks divided and assigned?
    - What roles do each participant adopt?
    - How do individual differences affect collaboration?
    - Similarities/differences between manual and intellectual collaborations
- What are the roles of diagrams in collaboration, and how can they be more facilitative?
    - Facilitate joint understanding
    - Facilitate joint reasoning

How Diagrams Facilitate

Individual cognition

- Reduce cognitive load
- Facilitate inference-making
- Promote comprehension & memory

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Collaborative cognition

- Visible, sharable common ground
- Resolve differences in mental conceptions
- External slate for joint reasoning

Previous Research

- Diagrammatic communication with schematic figu
- Mental models of complex systems from text and d
- Text and diagrams in instructions

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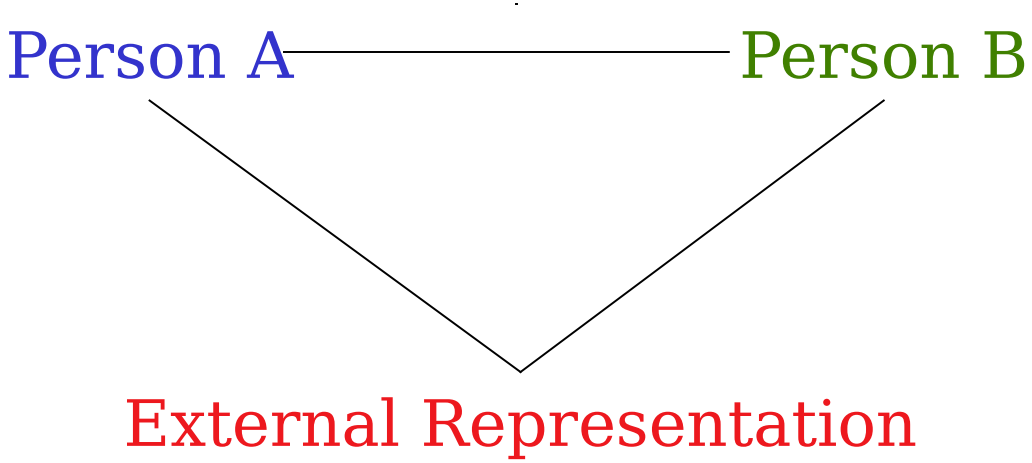

Experiments

1) Dyad planning assembly instructions

    - Constructing object
    - Writing instructions

2) Dyad “search and rescue” planning

    - Creating external representation
    - Constructing rescue plan

Prior Assembly Experiments

Individuals assembling object, creating instructions

Differences manifest in:

- method of assembly
- time to assemble
- instructions written
  - use of diagrams
  - use of text
  - quality
  - formatting

Assembly Experiment

Method

- 20 dyads assemble object with no instruction
- Experience questionnaire and spatial ability
- Create instructions for assembly

Assembly Experiment

Coding assembly and instruction planning

- communicating: gestures vs. language
- reconciling expertise, explaining
- reconciling differing conceptual models
- division of labor

Planning Instructions Video

Look for:

- Gestures denote parts; pointing instead of speaking
  for referring, faster and less ambiguous

- Gestures demonstrate assembly: showing instead of
  explaining

- Greater detail in gesture in response to question;
  hierarchical structure of gestures

- Plane changes in gesture, from upright

Planning Instructions Video

Video – assemb1

Preliminary Results

Dividing labor:

- Explicit components
- Implicit components

Asymmetry in collaboration:

- Right hand: fine work
- Left hand: support

Asymmetry in Teamwork

Experiment in Progress

“Search and Rescue” - plan route to rescue injured on Stanford campus after hypothetical earthquake

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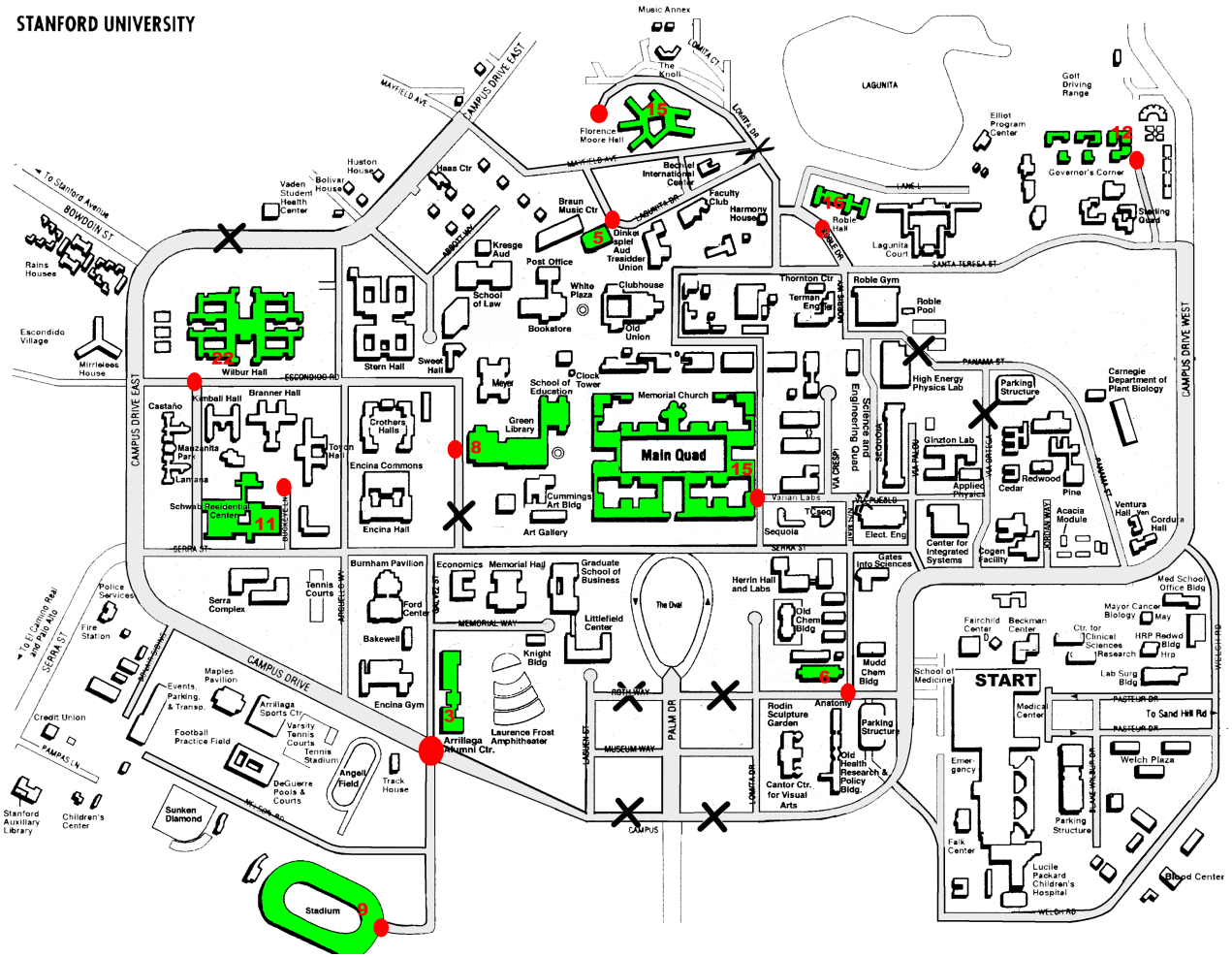
“Search and Rescue” - plan route to rescue injured on Stanford campus after hypothetical earthquake

Method

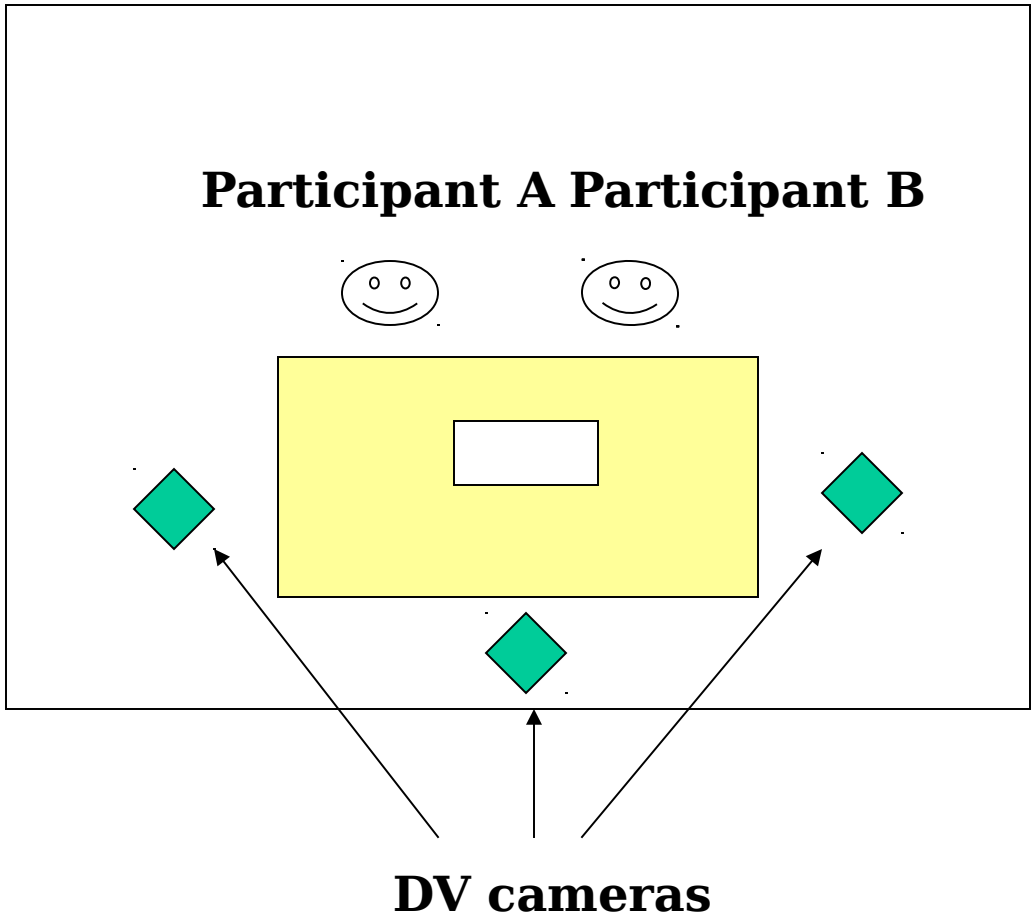
30 sets of dyads

- Co-present: working together
- Remote: working in divided room

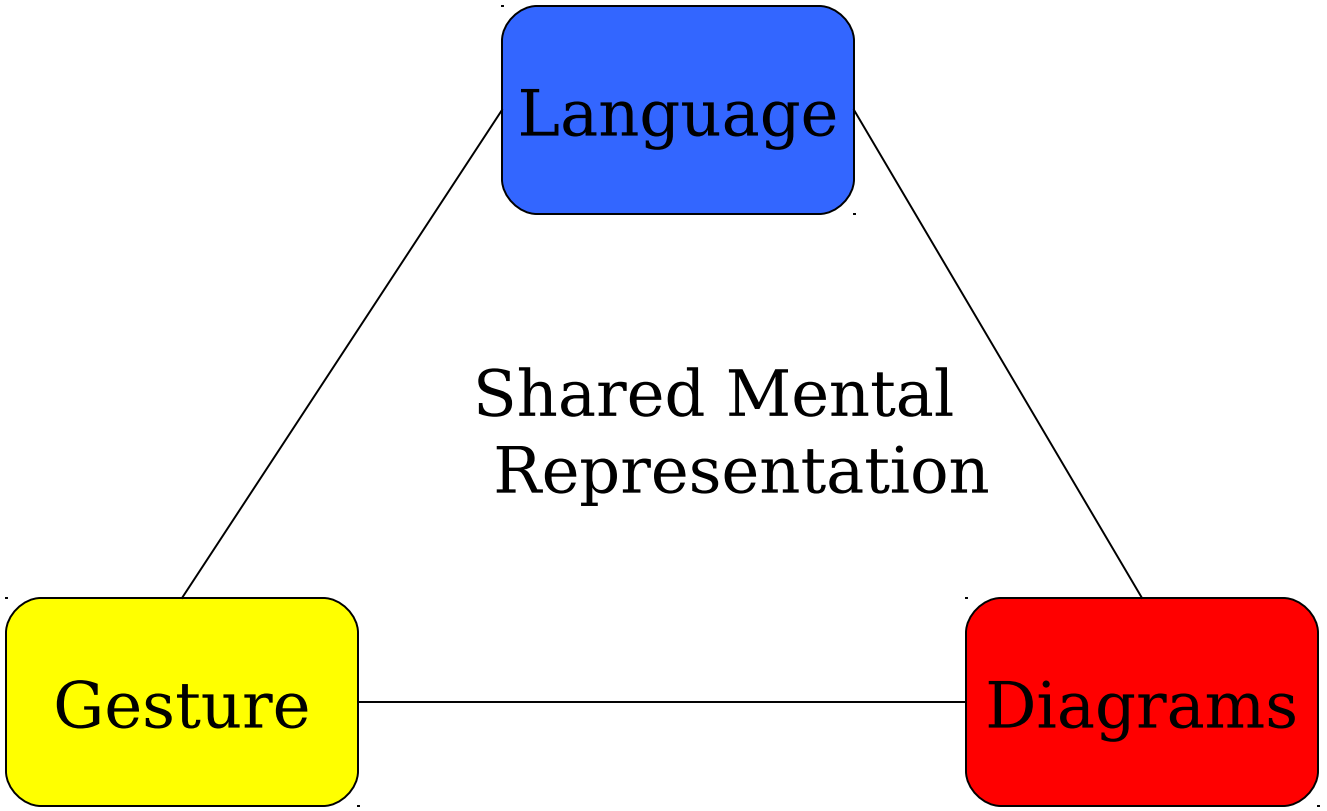
Emergency Situation



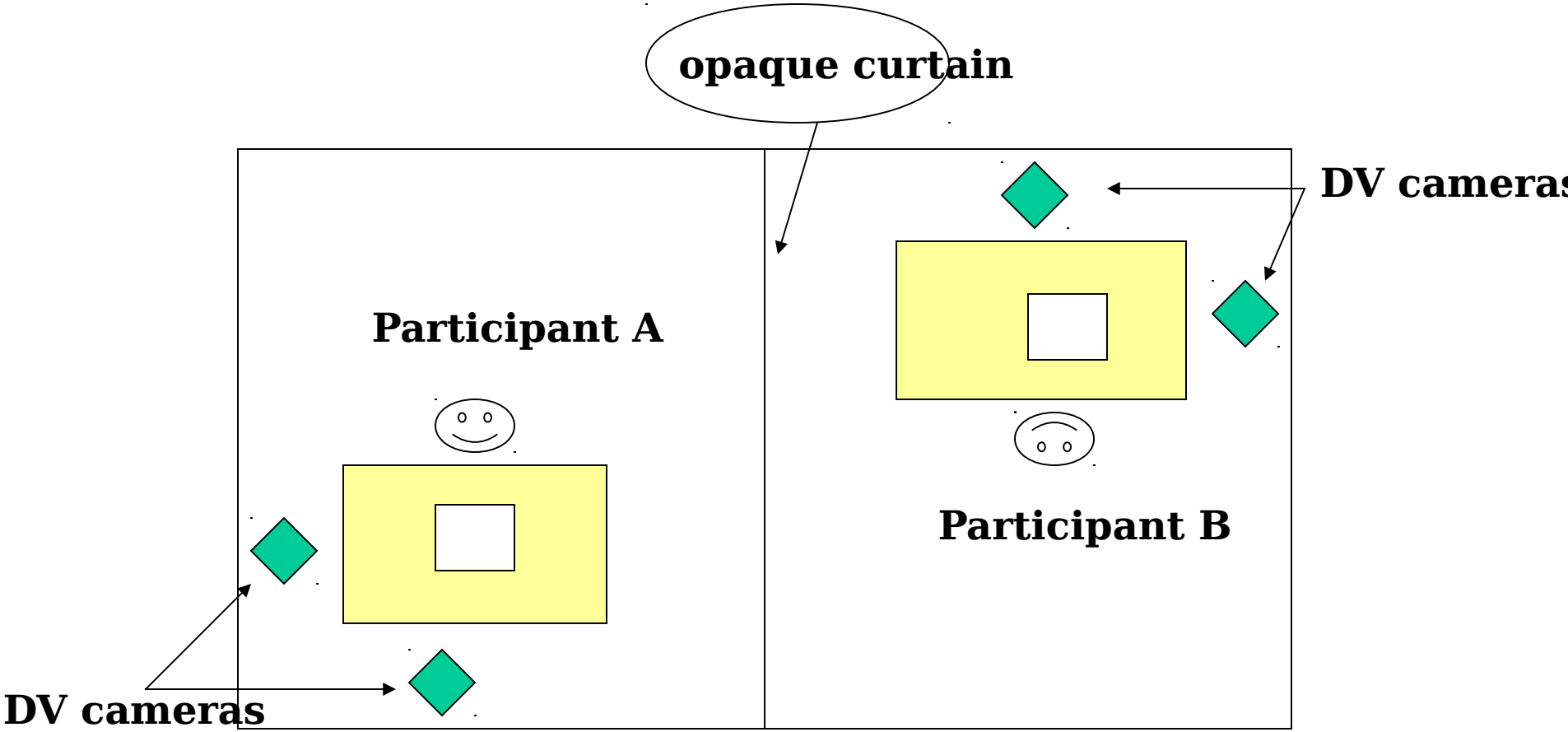
Co-Present Set-up



Co-Present Collaboration



Remote Set-up



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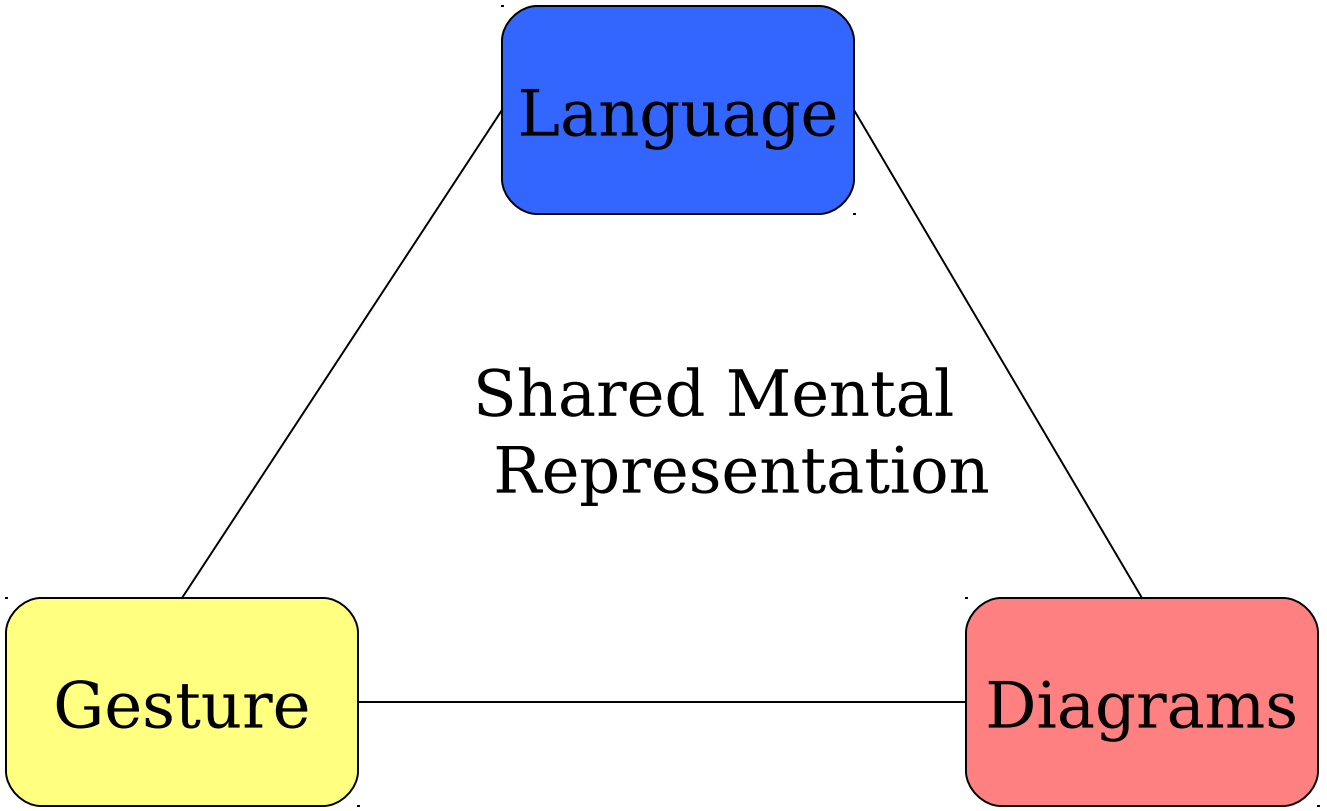


Search and Rescue data

Remote vs. Co-Present collaboration

- Time to solve problem
- Quality of solution
- Collaboration style
- Effects of shared representation/gesturing
- Different uses of language

Remote collaboration

- Maps/plans generated
- Perceived efficiency

Search and Rescue predictions

Use of language, gesture and shared external representations facilitate collaboration:

- More efficient planning and decision-making
- Better solutions

Constructing map jointly

- Simplifies information to relevant information
- Reconciles differences in conception

Pilot observations

Gesturing on map replaces language

- Referring
- Reasoning
- Proposing solutions
- Signaling assent
- Questioning
- Clarifying solutions
- Modifying solutions

Rescue Planning Video 1

Look for:

- Gestures outline route
- Gestures confirm understanding
- Gestures propose solutions
- Diagram serves as platform for
    - Joint understanding
    - Reasoning

Rescue Planning Video 1

Video – rescue1

Rescue Planning Video 2

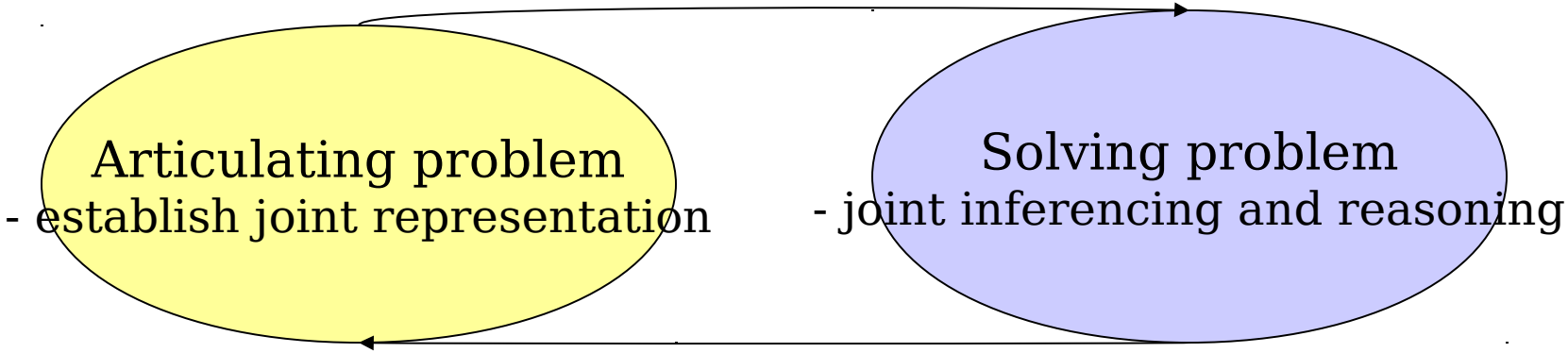
Look for:

- Gesturing key spots instead of route
  - diagrammatic shortcut
  - verbal shortcut
- Gestures propose solutions and counter-solutions
- Entrainment in
  - feedback to partner, like “OK”
  - common “language”

Rescue Planning Video 2

Video – rescue2

Model of Collaboration



- Iterative and hierarchical
- Parallel to representations and operations in individual mind

Summary

In collaborative interactions, external representations:

- Serve as a visible common ground
- External slate for reasoning
- Short cut verbal communication, more efficient problem-
  solving/planning decision making
- Sharing & using diagrams externalizes differences forcing
  cognitive structures to be reconciled

This Year's Objectives

- Analyze dyad assembly and planning instruction
- Finish running dyads in search and rescue study
- Refine model of collaboration and guidelines for facilitating effective collaboration
- Aim to understand how gesture, language and external representations interact in effective collaboration

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What's needed?

Research and development of:

- Tools that facilitate multi-modal collaborative interactions

- Tools that elicit shared cognitive structures on collaborative tasks